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Attorney Docket No.
062891.0340

Sir:

     Transmitted herewith for filing is the patent application of:

Inventors: Buckland, et al.

For: METHOD FOR USING A PRE-CONFIGURED TDM SWITCH AND
   TRAFFIC DISCARD TO FACILITATE UPSR SELECTION

Enclosed are: 1 Sheet of Formal Drawings

FEE CALCULATION					FEE
	Number		Number Extra	Rate	Basic Fee $760.00
Total Claims:	26	-20 =	6	X $18 =	$108.00
Independent Claims	3	- 3 =	0	X $78 =	$0.00
			TOTAL FILING FEE =		$868.00

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Attorneys for Applicants

October 6, 1999
    Date
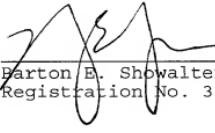
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DAL01:464440.1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Buckland, et al.
Date Filed: October 6, 1999
Title: METHOD FOR USING A PRE-CONFIGURED
                          TDM SWITCH AND TRAFFIC DISCARD TO
                          FACILITATE UPSR SELECTION

BOX PATENT APPLICATION

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METHOD FOR USING A PRE-CONFIGURED TDM SWITCH AND
TRAFFIC DISCARD TO FACILITATE UPSR SELECTION

CROSS-REFERENCE TO RELATED APPLICATIONS

　　　This application is filed concurrently with a
commonly-owned application entitled METHOD FOR USING A
PRE-CONFIGURED ATM SWITCH AND TRAFFIC DISCARD TO
5　　FACILITATE UPSR SELECTION.

TECHNICAL FIELD OF THE INVENTION

　　　This invention relates to technology in a digital
network and more particularly to techniques for
10　　protection switching of SONET UPSR.

BACKGROUND OF THE INVENTION

The synchronous optical network (SONET) standards for optical transmission include a number of mechanisms and recommendations for protecting transmitted traffic. These include making use of "rings" that contain all of the transmission termination points. Such rings provide two paths between each transmission point on the ring, thus providing a level of redundancy. There are two basic ways to exploit SONET rings to protect traffic: a uni-directional path switched ring (UPSR) and a bi-directional line switched ring (BLSR).

A UPSR operates by having two copies of the same traffic go in opposite directions from one side of a SONET ring to the other. At the exit point from the ring, the traffic from the two directions is compared, and the better version is selected for output. This approach can be utilized for time division multiplexed (TDM) traffic using virtual tributary (VT) comparison. Specifically, the overhead associated with each VT that provides performance indications is inspected to determine which path exhibits better performance by whatever performance criteria is chosen.

Traditional approaches to UPSR for TDM involve switch reconfiguration. Specifically, a TDM switch is provided at the ring node where the VT is being extracted from the ring. The TDM switch is configured to switch the TDM traffic from one of the two VT copies through to a destination. When the VT performance measures indicate that the VT copy being discarded has become the superior or preferred version of the two VT copies, the TDM switch is reconfigured to switch through this VT copy and to

ignore the original VT copy. Such reconfigurations can
be carried out indefinitely.

    This type of TDM switch reconfiguration approach
severely taxes the processing resources, such as a

5   microprocessor (or other computing entity) that is
controlling the switch. Reconfiguration is often a
computationally involved task. The SONET standards
require that switch reconfiguration occur within 50 ms of
the failure of a transmission link that is carrying the

10   active VT copy. This standard may not always be met
under certain conditions.

SUMMARY OF THE INVENTION

According to the invention, SONET UPSR protection is effected by configuring a TDM switch to route TDM traffic from two receive circuits to the same destination. Based on UPSR traffic qualification, one copy of this traffic is discarded in the TDM switch so that only a single copy is passed to the TDM switch. Based upon received performance measurements, the circuit performing the discard operation can change. The same or similar mechanism can be used to protect against equipment failure and accommodate removal of one of the receive circuits.

In a particular embodiment, an apparatus includes a number of receive circuits coupled to monitor signals on respective paths to a TDM switch. Each receive circuit sets a kill-bit to accompany TDM traffic sent to the TDM switch to indicate whether the TDM traffic should be switched or discarded. A memory coupled to the receive circuits receives the TDM traffic with accompanying kill-bits and stores the TDM traffic having an accompanying kill-bit that has not been set. The memory discards the TDM traffic having an accompanying kill-bit that has been set. A communication path between the receive circuits conveys qualifying information for the paths.

This overall approach, including configuration of the TDM switch such that it routes both VT copies through to the destination, allows for very fast switch-overs between VT copies. These switch-overs are achieved using decentralized processing in the receive circuits, with controlling messages sent between those circuits. Therefore, the processing drain for any microprocessor

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controlling the TDM switch due to switch-overs may be
reduced or eliminated. Other technical advantages are
readily apparent to one skilled in the art from the
following description, figures, and claims.

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BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, and for further features and advantages, reference is now made to the following description taken in conjunction with the accompanying drawings, where like reference numerals represent like parts, in which:

FIGURE 1 is a block diagram of a TDM communication network according to the invention; and

FIGURE 2 is a block diagram of components in a node of the network illustrating the function of a TDM switch in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIGURE 1 is a block diagram of a TDM communication network 10 according to the invention. The nodes 12, 14, 16 and 18 may each include TDM switches as described

5   below. Signal source 13 routes its traffic into node 12 which directs duplicate signals to node 18 via two paths, one though node 14 and node 16 and the other to node 18. Node 18 receives both signals, selects the best or preferred signal, and routes the selected signal to a

10   destination 19.

Referring to FIGURE 2, at node 18, a TDM switch 22 can switch both VT copies through to destination 19. Kill-bits inserted by receive circuits 24, 26 control which VT copy is actually switched through on a byte-by-

15   byte basis. In a particular embodiment, VT copies sent from receive circuits 24, 26 include the original eight bits and an additional kill-bit (nine bits total).

Receive circuits 24, 26 couple to a memory 20 for storing and forwarding traffic to TDM switch 22. Memory

20   20 stores an eight bit value for communication to TDM switch 22 if the kill-bit (9th bit) is not set. If the kill-bit is set, memory 20 discards or does not write the corresponding eight bit value to memory. Receive circuits 24, 26 exchange messages using bus 34 and/or

25   link 38 to determine, based on VT performance measurements, the better VT copy. Based on this determination, one of the two receive circuits 24, 26 sets kill-bits to prevent writing of VT copies to memory 20. The other receive circuit 24, 26 does not set kill-

30   bits so that its VT copies are written to memory 20 and passed to TDM switch 22. The receive circuit 24, 26 that

sets kill-bits to indicate discard can change based on
changes in VT performance measurements.

For the purposes of selecting between two copies,
VTs and STS-1 paths are qualified using the following

5   criteria:

1. Alarm indication signal (AIS), loss of pointer
(LOP), or terminating circuit card missing;

2. Bit error rate (BER) exceeding 10^{-3} in the path,
or other selected value; and

10   3. Signal degradation (SD) resulting from a BER
exceeding 10^{-5} to 10^{-9}, or other selected value.

To perform the VT qualification, each receive
circuit 24, 26 includes a decision module 30, 32 having
memory and processing capabilities to perform the VT

15   qualification. Decision modules 30, 32 each communicate
information using bus 34 supported by control module 36.
In a particular embodiment, bus 34 is functionally a
cross-connect DS-0 implemented using a time-slot
interchanger in control module 36. Decision modules 30,

20   32 may also communicate information for VT qualification
using link 38 between receive circuits 24, 26. In one
embodiment, link 38 supports a periodic keep-alive signal
between receive circuits 24, 26 to detect equipment
failure and/or removal, whereas bus 34 supports

25   communication of qualification criteria between circuits
24, 26, such as AIS, LOP, BER, and SD.

In a particular embodiment, communications between
receive circuits 24, 26 occur in a master/slave
environment. For purposes of this discussion assume

30   receive circuit 24 is the master circuit, while receive
circuit 26 is the slave circuit. In this embodiment,

receive circuit 26 reports the qualification status of
each VT upon which it receives traffic. Receive circuit
24 also determines the qualification status of each VT
upon which it receives traffic, and also receives reports
5   from receive circuit 26. Receive circuit 24 then
selects, based on the qualification criteria, the active
receive circuit 24, 26 to pass the VT traffic to TDM
switch 22. The designation of master and slave may not
change, but the active and stand-by status of receive
10   circuits 24, 26 for passing particular VT traffic may
change.

In operation, each receive circuit 24, 26 determines
the VT for each received telephony byte, block, packet,
or other portion of information, and performs a look-up
15   in a table maintained by decision modules 30, 32. For
each VT, the table includes a pass-through bit or other
indicator specifying whether the particular VT carries
pass-through traffic not intended for destination 19.
For example, pass-through traffic may include information
20   passed through node 18 from node 16 to node 12 or
information passed through node 18 from node 12 to node
16. If the pass-through bit indicates pass-through
traffic, then no further VT qualification processing is
performed. In a particular embodiment, control module 36
25   populates tables maintained by decision modules 30, 32
with pass-through bits for each provisioned VT. If the
pass-through bit for the determined VT indicates that
information is to be routed to destination 19, then a
qualification bit or other indicator specifies which
30   receive circuit 24, 26 is currently active (passing

traffic to TDM switch 22) and which receive circuit 24,
26 is stand-by (discarding traffic).

     In the particular embodiment illustrated in FIGURE
2, receive circuit 24 receives a telephony byte from node
16 on a particular VT, and decision module 30 performs a
table look-up using the VT to determine that this byte is
not pass-through (e.g., pass-through bit is set to zero),
and that receive circuit 24 is active (e.g.,
qualification bit is set to one). As a result, receive
circuit 24 does not set the kill-bit so that memory 20
stores the byte for communication to TDM switch 22.
Receive circuit 26 receives a copy of the byte from node
12, performs a table look-up at decision module 32 using
the same VT, and determines that this is not pass-through
traffic, but that receive circuit 26 is stand-by for this
particular VT. As a result, receive circuit 26 sets the
kill-bit so that memory 20 does not store the byte.

     For a variety of reasons, receive circuit 24 as the
master may determine that it should no longer be active.
This determination may be made based on the receipt at
receive circuits 24, 26 of management traffic passed
through or injected in the communication path from signal
source 13 to node 18. For example, node 14 may detect an
AIS condition between node 12 and node 14 due to, for
example, an optical fiber cut. In this situation, node
14 inserts management traffic for transmission to node 18
through node 16. Receive circuit 24 receives the
management traffic and determines that receive circuit 26
should be active. Receive circuit 24, still acting as
master, sets the qualification bit in the table

maintained by decision module 30 to indicate that receive
circuit 24 is stand-by, and sends a message using bus 34
or link 38 to command receive circuit 26 to operate as
active. Receive circuit 26 sets the qualification bit in
5   the table maintained by decision module 32 to indicate
that receive circuit 26 is active, and begins passing
bytes to be stored by memory 20 for communication to TDM
switch 22.

        A similar operation can take place if receive
10   circuit 24 receives management or overhead traffic
containing BER, SD, or other qualification criteria for
the particular VT. This overhead or management traffic
may either be sent as bad messages to indicate a degrade
or loss in signal, or as periodic polling messages that,
15   if absent, may indicate a degrade or loss in signal.
Moreover, receive circuit 26 may perform a switch-over to
active upon the detection of a loss of a keep-alive
signal from receive circuit 24 over link 38. Therefore,
receive circuits 24, 26 contemplate both VT level and
20   card or circuit level metrics for qualification of
signals. In any of these various embodiments, receive
circuits 24, 26 communicate over bus 34 and/or link 38 to
allow decision modules 30, 32 to determine the
active/stand-by status of receive circuits 24, 26.

25   If SONET UPSR is being applied to STS-1 type blocks
(possibly forming larger STS-N signals), the same general
approach can be applied. That is, TDM switch 22 can be
configured to switch through both copies of an STS-1
block arriving in two directions around a UPSR ring.
30   STS-1 path level performance indications are used by

receive circuits 24, 26 to determine in a distributed
manner which should set kill-bits to force the discard of
its copy of the STS-1.

This UPSR approach, whether used for TDM or STS-1

5   traffic, can be generalized to select between two copies
of any traffic stream coming from any two directions,
regardless of whether or not the two traffic streams
actually pass over SONET rings or other network
configurations. This approach can be further generalized

10   to select between traffic from a number of sources (more
than two), including from redundant switches within the
same unit.

Although the present invention has been described
with several embodiments, a myriad of changes,

15   variations, alterations, transformations, and
modifications may be suggested to one skilled in the art,
and it is intended that the present invention encompass
such changes, variations, alterations, transformations,
and modifications as fall within the scope of the

20   appended claims.

WHAT IS CLAIMED IS:

    1.   In a TDM network having a plurality of switchable paths to a common destination, a method comprising:

5   receiving TDM traffic from a traffic source as a plurality of copies of traffic routed along a plurality of paths, each one of said paths having a receive circuit;

    configuring a TDM switch to provide a route to a

10   common destination for each one of the paths;

    determining a qualified copy of the traffic; and

    discarding all copies of the traffic except for the qualified copy such that only the qualified copy is passed to the TDM switch for routing to the common

15   destination.

    2. The method of Claim 1, wherein determining comprises receiving management traffic on a path indicating a degradation or loss of signal on the path.

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    3.   The method of Claim 1, wherein determining comprises detecting a loss of a keep-alive signal at one of the respective receive circuits.

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4.   The method of Claim 1, wherein determining is
based upon the following criteria:
    alarm indication signal (AIS),
    loss of pointer (LOP), or
5   missing terminating circuit card; thereafter
    bit error rate (BER) exceeding 10^{-3} in the path;
thereafter
    signal degradation (SD) resulting from a BER
exceeding 10^{-5} to 10^{-9}.
10

5.   The method of Claim 1, wherein discarding
comprises setting a kill-bit to indicate whether the
traffic should be switched through or discarded.

15   6.   The method of Claim 1, wherein determining
comprises communicating information related to qualifying
between the respective receive circuits.

7.   The method of Claim 1, wherein the paths
20   comprise a first path in a first direction around a SONET
UPSR and a second path in a second direction around the
SONET UPSR.

8.   The method of Claim 1, wherein the TDM traffic
25   is carried in VT or STS-1 formats within a transmission
signal.

9.   The method of Claim 1, wherein the TDM switch
is configured to route TDM traffic for a given virtual
tributary (VT) from each respective receive circuit to
the common destination.

        10.   In a TDM network having a plurality of paths to
a destination, an apparatus comprising:
        a plurality of receive circuits coupled to monitor
signals on respective paths to a TDM switch, each receive
5   circuit operable to set a kill-bit to accompany TDM
traffic sent to the TDM switch to indicate whether the
TDM traffic should be switched or discarded;
        a memory coupled to the receive circuits and
operable to receive the TDM traffic with accompanying
10   kill-bits, the memory operable to store the TDM traffic
having an accompanying kill-bit that has not been set,
the memory further operable to discard the TDM traffic
having an accompanying kill-bit that has been set; and
        a communication path between the receive circuits
15   and operable to convey qualifying information for the
paths.

        11.   The apparatus of Claim 10, wherein each receive
circuit is operable to qualify TDM traffic by receiving
20   management traffic on a path indicating a degradation or
loss of signal on the path.

        12.   The apparatus of Claim 10, wherein each receive
circuit is operable to qualify TDM traffic by detecting a
25   loss of a keep-alive signal of another receive circuit.

13. The apparatus of Claim 10, wherein each receive circuit qualifies the TDM traffic based upon the following criteria:

alarm indication signal (AIS),

loss of pointer (LOP), or

missing terminating circuit card; thereafter

bit error rate (BER) exceeding 10^{-3} in the path; thereafter

signal degradation (SD) resulting from a BER exceeding 10^{-5} to 10^{-9}.

14. The apparatus of Claim 10, wherein each receive circuit is further operable to:

receive TDM traffic associated with a virtual tributary (VT);

determine if the TDM traffic is pass-through based on the VT; and

if the TDM traffic is not pass-through, set an accompanying kill-bit if the receive circuit is stand-by for the particular VT.

15. The apparatus of Claim 10, wherein the paths comprise a first path in a first direction around a SONET UPSR and a second path in a second direction around the SONET UPSR.

16. The apparatus of Claim 10, wherein the TDM traffic is carried in VT or STS-1 formats within a transmission signal.

17.   The apparatus of Claim 10, wherein the TDM switch is configured to route TDM traffic for a given virtual tributary (VT) from each receive circuit to the destination.

18. A program embodied in computer-readable media and operable to perform the following steps:

receiving, at a receive circuit, TDM traffic from a traffic source as one of a plurality of copies of traffic routed along a plurality of paths;

5 determining, at the receive circuit, whether the received copy is a qualified copy of the traffic;

discarding the received copy if the received copy is not the qualified copy; and

10 communicating the received copy from the receive circuit to a TDM switch for routing to a destination if the received copy is the qualified copy.

19. The program of Claim 18, wherein determining comprises receiving management traffic at the receive

15 circuit indicating a degradation or loss of signal on a corresponding path.

20. The program of Claim 18, wherein determining

20 comprises detecting a loss of a keep-alive signal.

21.   The program of Claim 18, wherein determining is based upon the following criteria:

       alarm indication signal (AIS),

       loss of pointer (LOP), or

5   missing terminating circuit card; thereafter

       bit error rate (BER) exceeding 10^{-3} in the path; thereafter

       signal degradation (SD) resulting from a BER exceeding 10^{-5} to 10^{-9}.

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22.   The program of Claim 18, wherein discarding comprises setting a kill-bit to indicate whether the traffic should be switched through or discarded.

15   23.   The program of Claim 18, wherein determining comprises communicating information related to qualifying to another receive circuit.

       24.   The program of Claim 18, wherein the paths

20   comprise a first path in a first direction around a SONET UPSR and a second path in a second direction around the SONET UPSR.

       25.   The program of Claim 18, wherein the TDM

25   traffic is carried in VT or STS-1 formats within a transmission signal.

26.   The program of Claim 18, wherein the TDM switch is configured to route TDM traffic for a given virtual tributary (VT) from each of the paths to the destination.

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METHOD FOR USING A PRE-CONFIGURED TDM SWITCH AND
TRAFFIC DISCARD TO FACILITATE UPSR SELECTION

ABSTRACT OF THE DISCLOSURE

     A TDM switch is configured to route TDM traffic from
two receive circuits to a destination. One copy of the
traffic is discarded, and a memory selectively stores the
other copy for routing to the TDM switch. Receive
circuits contemplate both virtual tributary (VT) level
and card or circuit level metrics for qualification of
signals.

FIG. 1

FIG. 2
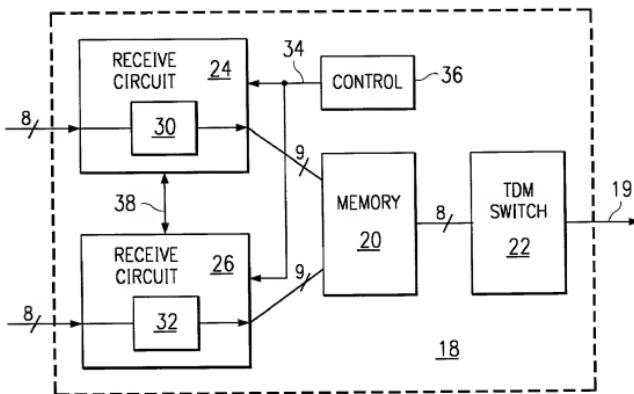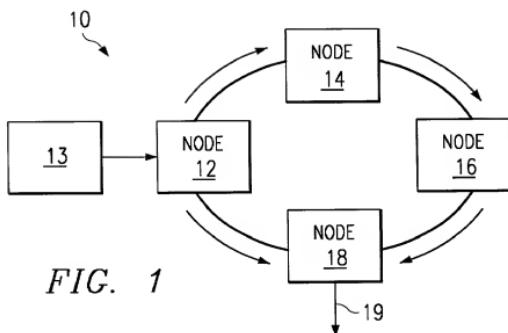
DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I declare that:

My residence, post office address and citizenship are as stated below next to my name; that I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention or design entitled METHOD FOR USING A PRE-CONFIGURED TDM SWITCH AND TRAFFIC DISCARD TO FACILITATE UPSR SELECTION the specification of which is attached hereto; that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above; and that I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

		Date	Priority Claimed	
Number	Country	Filed	(Yes)	(No)
--------------------------NONE--------------------------------				

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application(s) in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. § 1.56 which became available between the

filing date of the prior application(s) and the national or PCT
international filing date of this application:

    Application
  Serial Number   Date Filed   Status

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I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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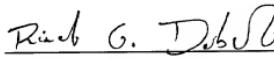
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